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ABSTRACT: Fire, weather and vegetation patterns are key elements of the natural environment viewed in human perspective. Knowledge of the causes that configure the structure and spatial distribution of vegetation is the cornerstone in sustainable development, especially in agricultural production, forest management and land use planning. Strong correlation exists among physical and human elements of the environment that determine wildfire and vegetation dynamics. This paper examines the differences in spatial distribution of wildfires and vegetation in two peninsulas of northern Greece with the use of modern geo-informatics procedures and technology (i.e., multivariate digital processing in time and space). Logistic regression models were applied in a spatial database that has been developed and managed within a Geographic Information System (GIS). Cartographic vegetative information were statistically correlated with basic impact factors (e.g., geomorphology, climate, fire history, land use and human activities) to estimate the rate and magnitude of their influence in a landscape scale.

1 INTRODUCTION

Spatial and temporal attributes are important characteristics in landscape and wildfire dynamics; spatial analysis varies between local and global scales, while temporal resolution can be either short- or long-term. These fire, weather and vegetation features compel the use of Geographic Information Systems (GIS) that have the ability to manage effectively spatial and temporal information in widespread applications (Chou 1992, Chuvieco & Congalton 1989, Salas & Chuvieco 1994, Salas *et al*. 1994).

Mapping of the vegetation in fire dynamics is the most complicated procedure due to the fact that the presence of different species will not always result in different fire occurrence probabilities. Wildfire occurrence is strongly correlated with the morphology (height, density), status (moisture) and quantity of vegetation which determine the fuel models (Andrews 1986, Deeming *et al.* 1977).

The study of the interactions between wildfire and vegetation of a particular area provides essential information about potential combinations regarding various ecological factors such as humidity, temperature, terrain, soils, human activities, wildfire frequency etc. that in reality can result in infinite combinations. For example, although the temperature may be one of the major factors that affect vegetation and wildfire occurrence, at the same time it varies according to the time of the day or the particular location on a tree's or plant's surface. Therefore, one might come across an unstable temperature value which varies in time and space. This situation might be more complicated by the numerous combinations of soil quality and composition which differ every few meters.

As a result, the evaluation of the influence of the various ecological factors is practically impossible. However, the development of Plant Ecology attempts a grouping of these factors so that their impacts can be estimated via the different plant species that compose an area's vegetation. In effect, each research study is conducted in a subtractive manner since only a few of the enormous amount of ecological factors are useful for their interactions with nature. Although, new technologies may increase the ability of evaluating more and more factors, still their number involves very few compared to reality.

Knowledge of the various environmental factors and of their impact upon the formation of the vegetation, and especially of their different combinations, can be extremely critical since their recording, mapping and evaluation might help land managers to avoid mistakes while practicing applied forestry; for the biological balance is a dynamic, not static, phenomenon and nature is a field of constant changes which the scientists must monitor in order to avoid unpleasant situations for humans. Nature can never be the same in any given moment, because even the human factor must be taken into account when determining the practice of an economic or agricultural policy resulting in negative impacts (e.g., overgrazing practices), which can lead to land degradation of vast areas.

This research attempts to study the interactions between wildfire occurrence and the formation of vegetation under the impact of various environmental factors and the human presence and activities. Different wildfire and vegetation patterns were analyzed through the use of geo-informatics technology (multivariate digital processing in time and space), especially by applying logistic regression models in a spatial data base created and managed in a GIS.

The necessity of correlating and analyzing descriptive statistics data with their respective spatial distribution establish the GIS as a powerful and flexible tool. The advantages that prompted the choice of the GIS as a tool for analyzing the effects of the wildfire, human and environment factors are geographically:

- Input and analysis of descriptive and spatial data in digital format.
- Correlation and analysis of peripheral statistical data to respective spatial data.
- Development of models for managing and processing data.
- Processing of a greater number of data, which is something that cannot be achieved through traditional methods.
- Presentation of final results in any scale and map type.

2 THE STUDY AREA

The peninsulas of Sithonia and Athos, at the northern part of Greece, have been chosen as study areas since their terrain is similar and are located in the same climatic zone; therefore, having similar environmental factors, can provide comparable data. Despite their ecological similarities, the grater part of the vegetation remains completely different in the two areas. Sithonia is consisted exclusively of evergreen forest lands, while Athos is mainly covered by deciduous trees. Due to the fact that these two areas have been developing under completely different socio-economical conditions over the past millennium, the evaluation of the impact of human activity and the environment in the formation of their vegetation and the spatial distribution of wildfires was considered to be an excellent research opportunity (Fig. 1).

Sithonia is the middle, out of three, peninsula of Chalkidiki. Its population amounts to 9124 permanent residents distributed uniformly. During the summer period, coast areas accept more than 300000 visitors which result in extensive human pressure to the environment.

Geologically, Sithonia belongs to the Serbo-Macedonian massif and Peri-Rodopian zone. The intensive multi-format of terrain is depicted by narrow and wide valleys and ravines, and steep coasts and slopes. Polielaios is the highest mountain peak and rises to 823 m. Rivers and lakes are not considerable in this peninsula. The igneous rocks that extend to eastern area result to acid, shal-

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low and infertile soils while the west side is composed by limestones. According to the Köppen classification system, Sithonia belongs to climate types Csa and Csb.

Athos or Holy Mountain (the renowned monastery state) is the eastern peninsula of Chalkidiki with 3000 permanent resident monks in 20 monasteries, spread out in all over the area. Geologically, Athos belongs to the Rodopian crystallized complex. The terrain is characterized as mountainous without any significant plain, and the highest peak is Mount Athos (2033 m) at the southern end of the peninsula.

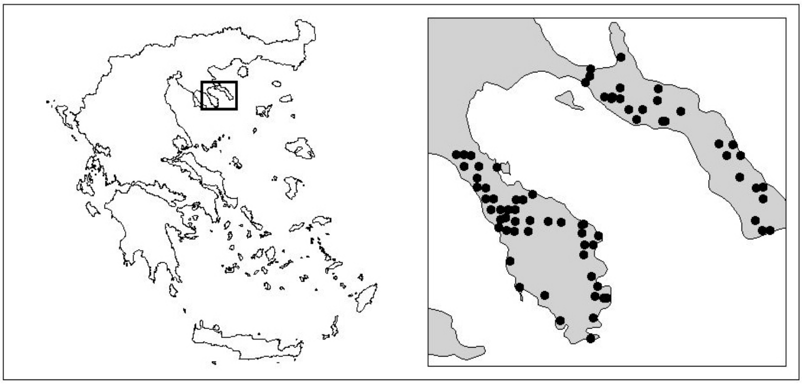

Figure 1. The two study areas in Chalkidiki, Greece (left map), and spatial distribution of ignition points in Sithonia and Athos (far eastern peninsula), respectively (right map)

3 METHODOLOGY

A complete geographical information system which consists of environmental variables (i.e., topography, geology, vegetation and meteorological data, land use cover types and human activities) has been created for the geographical space of the peninsulas of Sithonia and Athos, utilizing the Arc/Info software. The database has provided the ability of studying and statistically analyzing essential statistical correlations (Fig. 2).

3.1 *Logistic regression*

Logistic regression models is considered as the most suitable method for the probability estimation of an event occurrence (e.g., fire or vegetation cover) in case that the dependant or response variable is expressed in a binary way (Bachman & Algower 1998, Hosmer & Lemeshow 1989, Kalabokidis & Koutsias 2000, Schöning *et al*. 1997, Vasconcelos *et al*. 2001). Logistic regression model can be expressed with the function (Mendehall & Sincich 1996, Sharma 1996):

$$f(z) = \frac{1}{1 + e^{-(b_0 + b_1 X_1 + b_2 X_2 + ... + b_k X_k)}} \tag{1}$$

where X_k = qualitative or quantitative independent variables; b_k = estimated coefficients.

In this research, a number of logistic regression models have been developed. A spatial data base was created, mostly by map-sheets digitization, and every thematic layer was considered as an independent or explanatory variable in the logistic models. After the separation of the variables into categorical and continuous ones, multivariate statistical models were applied.

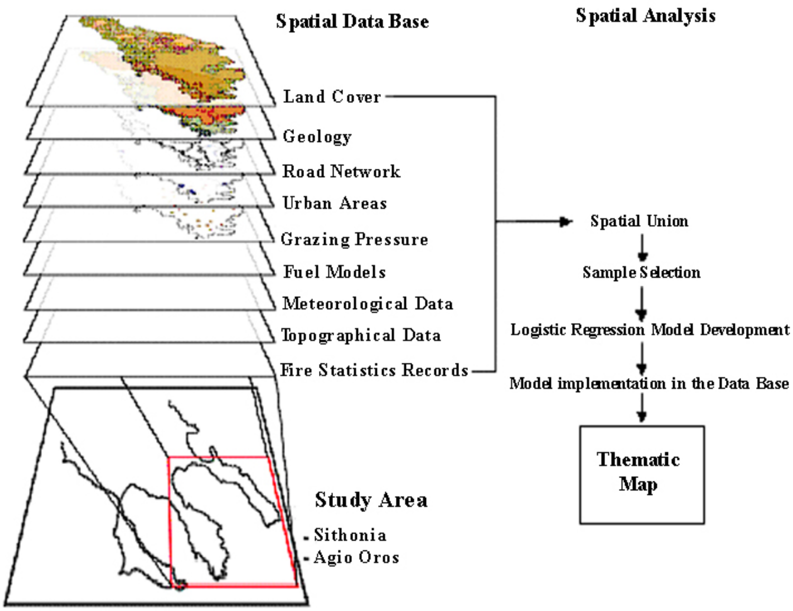

Figure 2. Diagrammatic presentation of the methodology

Elevation, slope and meteorological data were defined as continuous. Digital Elevation Model was created by interpolation of 20-m interval contours derived from topographic maps. Raw data from 5 meteorological stations were used to interpolate for their spatial distribution by applying multi-linear regression models with independent variables the Latitude, Longitude and Elevation. True values of the Temperature and Humidity data were imported in the logistic model while Rain was categorized according to Table 1.

Table 1. Continuous variables

VARIABLE	SOURCE	GROUPED VALUE	LEGEND
Aspect	Digital Elevation Model	0 90 180 270	0^o - 45^o & 315^o - 360^o 45^o - 135^o 135^o - 225^o 225^o - 315^o
Elevation	Digitized 20-m interval contours from 1:50000 scale map	100 300 500 …	0 – 200 200 - 400 400 - 600 ….
Rain (summer, July, August)	Data from 5 meteorological stations	0 25 50 …	0-12.5 mm 12,5-37.5 mm 37.5-62.5 mm …
Rain (annual)		… 500 525 …	… 500-512.5 mm 512.5-537.5 mm …

Table 2. Categorical variables

VARIABLE	SOURCE	VALUE	LEGEND
Distance to Roads	Topographic map (scale 1:50000, published 1969)	1	0-300m
		0	>300m
Distance to Urban Areas	Topographic map (scale 1:50000, published 1969)	1	0-300m
		0	>300m
Distance to Livestock[1]	Fieldwork and air-photographs	1	0-300m
		0	>300m
Distance to Stream Networks	Hydrological model applied to DEM	1	0-300m
		0	>300m
Slope	DEM	1	0-30%
		0	>30%
Geology	Geologic maps (scale 1:50000, published 1978)	1	Sedimentary Rocks
		2	Meta-sedimentary Rocks
		3	Igneous Rocks
Land Cover Types	Forest cover map (scale 1:200000, published 1991)	1	True Fir
		3	Black Pine
		4	Aleppo Pine
		5	Oak & mixed (with Birch-Black Pine-Chestnut Tree)
		6	Chestnut Tree & mixed (with Birch-True Fir)
		8	Evergreen Shrubs
		9	Grassland
		10	Agriculture
		11	Barren Soil
Fire	Fire ignition points and data mapping from Forest Service Offices of Poligiros and Arnaia	1	Burned Area
		0	Unburned Area

Dummy variables with binary values, 0 and 1, were created from all categorical and some continuous variables in order to be used in the logistic regression model (Table 2). Stream network was derived directly from the DEM and was categorized according to the Shreve ordering rule. For the data analysis only the network with order equal or greater than 3 was chosen. The advantage of this method is the accuracy of the network and the compatibility with DEM, while there are two main disadvantages: a) the produced stream network is the potential rather than the active network, and b) the inability to derive the network in flat areas. Historical fire event records from the Forest Service Offices were retrieved, and the radius of a circle with area equal to the actual burned area was calculated. A buffer/ burned zone (coded the value of 1) was created for every ignition point with the calculated radius simulating the actual burned area.

4 RESULTS

All the variables (27 thematic layers) were spatially overlaid in order to create a unique thematic layer in which every geographic unit differs from its neighborhoods in at least one variable. After the final creation of the dummy variables, a sample has been chosen for the statistical analysis. In wildfire pattern recognition, the depended variable was the burned area. Every geographic unit that was burned at least one time in the last decade, coded with the value 1, while the unburned coded with the value 0. In vegetation pattern recognition, a number of models equal to the number of dif-

[1] Only for Sithonia peninsula

ferent land cover types were developed. The existence of each land cover type was coded with the value 1, while all other area was coded with value 0.

Vegetation patterns were studied by developing 6 different probability models for Sithonia and 7 models for Athos in order to examine which factors influence the presence or the absence of the different cover types. This method was based on the hypothesis that the present distribution of the forest types in the study area is representative of its response to the environmental and human factors that have been considered in our study (Felicísimo *et al*. 2002).

Wildfire patterns were studied by developing seven different models for both peninsulas. Model 1 was developed in order to study the human impact on wildfire occurrence by including the variables dealing with proximity to human activities. The influence of geomorphology was studied with Model 2, while Model 3 was developed only with meteorological data. Model 4 included only the dummy variables that were reproduced from vegetation with the DEVIATION coding scheme (Norusis 1990). With this coding scheme, one could see the influence of each forest type to the presence of wildfire, compared to the average effect of all forest types.

Model 5 included all the variables and Model 6 included a selection of 12 variables for Sithonia and 11 variables for Athos. The selected variables were intuitively considered as the most 'logical' environmental and human factors that have an effect on the wildfire occurrence for both peninsulas. For Models 1 to 6, all variables were entered in a single step. In Model 7, a Forward Stepwise Selection performed according to likelihood-ratio (LR) criterion (Norusis 1990).

The correlation coefficients (R^2) ranged from 0.7 to 1.0 for the meteorological variables in the multi-linear regression method, performed to distribute the meteorological data (i.e., air temperature, relative humidity and rainfall) over space.

4.1 *Vegetation patterns recognition*

Table 3 shows the results of the vegetation patterns recognition analysis in Sithonia peninsula. Most of the variables are significant in explaining the presence of black pine (*Pinus nigra*) except the variables indicting the human impact due to higher elevations that these stands occur. Occurrences of aleppo pine (*Pinus halepensis*) and associated evergreen shrub vegetation (maquis) are influenced significantly by most of the variables but fire. Agricultural lands (grazing and farming lands) and barren soils seem not to be affected at the 95% confidence level by most of the study variables. Fire has no influence on the 5% significance level in all vegetation types, except for the farm lands that appear to expand by wildfires.

In Mt. Athos (Table 4), abundance of true firs (*Abies borisii regis*) is significantly dependant on environmental factors; whereas, deciduous oak (*Quercus conferta* & *Q. pubescens*) and chestnut tree (*Castanea sativa*) forests (both pure and mixed ones) do occur in association not only with environmental variables but also with anthropogenic influences. Aleppo pine and shrub lands are significantly affected by most of the study variables. Agriculture areas, as expected, are more evidently influenced by humans and their practices. Fire occurrence highly influences the presence and extent of all vegetation types in Mt. Athos.

Classification accuracies of all vegetation logistic algorithms averaged high percentage values that ranged from 75.5 to 95.7 for Sithonia (Table 3), and between 66.4% up to 96.6% for Athos (Table 4), depicting models that have the majority of their predictions correct.

4.2 *Wildfire occurrence patterns*

Proximity to roads seems to have a significant effect on wildfire occurrence (Table 5: Model 1) on both peninsulas of the Chalkidiki area; proximities to urban areas and livestock stables (2 other human impact variables) appear not to have conclusive evidence of influences. Geomorphology factors present a highly significant influence on fire occurrences in the rugged terrains of Chalkidiki, since elevation, slope, aspect and streams are all critical at the 5% significance level (Table 5: Model 2).

Fire and climate relationships are considered strong, especially seasonal air temperature, relative humidity and precipitation during the summer. All average and range climatic factors do prove to have a significant impact on wildfire occurrences not only in Sithonia but also in Mt. Athos (Table 5: Model 3).

The overall effect of vegetative cover, as expected, is highly significant on wildfires with each cover type being significant at the 5% level compared to the average effect of all the rest ones on both study peninsulas (Table 5: Model 4). Only, agricultural lands in Sithonia had not whatsoever a 95% significant difference between burned and unburned areas. All four models of Table 5 had low percentages of correct classifications (51.8 – 69.8 %).

Table 3. Results for the potential distribution of vegetation in Sithonia peninsula (BP: black pine; AP: aleppo pine; ES: evergreen shrubs; GL: grassland; AG: agriculture; and BS: barren soil)

Variable	Land Cover Type					
	BP	**AP**	**ES**	**GL**	**AG**	**BS**
Distance to Road Network	NS	NS	***	*	***	NS
Distance to Urban Areas	NS	***	***	NS	***	NS
Distance to Livestock	NS	***	***	NS	***	NS
Distance to Stream Network	***	***	***	NS	*	***
Elevation	***	***	***	NS	***	NS
Slope	***	***	***	*	***	NS
Aspect	***	***	*	NS	***	NS
Humidity – Summer	***	***	***	NS	NS	*
Humidity – July	**	***	NS	***	NS	*
Humidity – August	***	NS	NS	NS	NS	NS
Humidity – Annual	**	**	NS	**	NS	***
Rain – Summer	**	***	***	NS	NS	NS
Rain – July	***	NS	***	NS	***	NS
Rain – August	***	***	***	NS	***	NS
Rain – Annual	***	***	***	***	***	***
Temperature – Summer	***	***	***	**	NS	***
Temperature – July	***	***	***	NS	NS	NS
Temperature August	***	***	***	NS	NS	NS
Temperature – Annual	***	***	***	NS	NS	NS
Maximum Temperature – Summer	***	***	***	**	NS	NS
Maximum Temperature – July	***	NS	NS	NS	NS	*
Maximum Temperature – August	***	***	NS	NS	***	NS
Maximum Temperature – Annual	***	*	***	NS	***	NS
Minimum Temperature – Annual	NS	***	***	***	***	***
Geology	***	***	***	NS	***	***
Fire	NS	NS	NS	NS	***	NS
% CORRECT CLASSIFICATION	**94.3**	**75.5**	**80.0**	**95.2**	**80.0**	**95.7**

***: $0.000 \leq p \leq 0.001$
**: $0.001 < p \leq 0.01$
*: $0.01 < p \leq 0.05$
NS: $p > 0.05$ (non-significant)

Table 4: Results for the potential distribution of vegetation in Athos peninsula (TF: true fir; AP: aleppo pine; OA: oak; CT: chestnut tree; ES: evergreen shrubs; AG: agriculture; and BS: barren soil)

Variable	**Land Cover Type**						
	TF	**AP**	**OA**	**CT**	**ES**	**AG**	**BS**
Distance to Road Network	NS	***	NS	***	***	***	NS
Distance to Urban Areas	NS	***	***	***	*	*	NS
Distance to Stream Network	NS	***	***	***	***	**	NS
Elevation	**	***	***	**	***	***	NS
Slope	**	***	***	***	***	***	NS
Aspect	NS	***	***	***	***	NS	***
Humidity – Summer	NS	***	***	***	***	**	NS
Humidity – July	NS	NS	***	***	***	NS	NS
Humidity – August	*	***	***	***	***	NS	***
Humidity – Annual	**	***	NS	*	NS	NS	NS
Rain – Summer	NS	***	NS	***	***	***	NS
Rain – July	NS	NS	***	***	***	**	*
Rain – August	NS	***	***	**	***	***	***
Rain – Annual	***	***	***	***	***	*	***
Temperature – Summer	*	***	***	***	***	*	NS
Temperature – July	NS	***	***	***	*	NS	NS
Temperature August	NS	*	NS	***	**	NS	***
Temperature – Annual	NS	NS	***	NS	***	***	NS
Maximum Temperature – Summer	*	*	***	***	***	NS	*
Maximum Temperature – July	NS	***	***	***	**	NS	NS
Maximum Temperature – August	*	NS	***	***	***	NS	NS
Maximum Temperature – Annual	***	***	***	***	***	**	***
Minimum Temperature – Annual	***	***	***	***	***	NS	***
Geology	***	***	***	***	***	***	***
Fire	*	***	***	***	***	***	NS
% CORRECT CLASSIFI-CATION	**96.6**	**85.3**	**66.4**	**79.4**	**67.3**	**77.6**	**89.3**

***: $0.000 \le p \le 0.001$
**: $0.001 < p \le 0.01$
*: $0.01 < p \le 0.05$
NS: $p > 0.05$ (non-significant)

Table 5. Results for the wildfire occurrence models (***: 0.000 ≤ p ≤ 0.001, **: 0.001 < p ≤ 0.01, *: 0.01 < p ≤ 0.05, Non-significant-NS: p > 0.05)

Variable	**Human Impact (Model 1)**		**Geomorphology (Model 2)**		**Climate (Model 3)**		**Vegetation (Model 4)**	
	Sithonia	**Athos**	**Sithonia**	**Athos**	**Sithonia**	**Athos**	**Sithonia**	**Athos**
Distance to Road Network	***	***						
Distance to Urban Areas	NS	***						
Distance to Livestock	NS							
Distance to Stream Network			***	***				
Elevation			***	***				
Slope			**	***				
Aspect			***	***				
Humidity – Summer					*	**		
Humidity – July					**	***		
Humidity – August					***	***		
Humidity – Annual					***	**		
Rain – Summer					***	***		
Rain – July					NS	***		
Rain – August					***	***		
Rain – Annual					***	***		
Temperature – Summer					***	**		
Temperature – July					***	NS		
Temperature – August					***	NS		
Temperature – Annual					***	NS		
Maximum Temperature – Summer					NS	***		
Maximum Temperature – July					***	NS		
Maximum Temperature – August					NS	***		
Maximum Temperature – Annual					NS	NS		
Minimum Temperature – Annual					***	***		
Land Cover							***	***
True Fir								***
Black Pine							***	
Aleppo Pine							*	***
Oak								*
Chestnut Tree								***
Evergreen Shrubs							**	***
Grassland							NS	
Agriculture							NS	***
% CORRECT CLASSIFICATION	**51.8**	**52.9**	**69.8**	**56.4**	**69.3**	**57.9**	**61.1**	**67.4**

Table 6. Results for the wildfire occurrence models (***: 0.000 ≤ p ≤ 0.001, **: 0.001 < p ≤ 0.01, *: 0.01 < p ≤ 0.05, Non-significant-NS: p > 0.05)

Variable	All Variables (Model 5)		Selected Variables (Model 6)		LR Selection (Model 7)	
	Sithonia	Athos	Sithonia	Athos	Sithonia	Athos
Distance to Road Network	NS	***	NS	***		
Distance to Urban Areas	NS	***	*	***		
Distance to Livestock	***		***			
Distance to Stream Network	***	***			***	
Elevation	***	***	***	***	***	
Slope	***	***	***	***	***	
Aspect	NS	***	NS	***		
Humidity – Summer	NS	*	***	***		
Humidity – July	*	***				
Humidity – August	***	***				***
Humidity – Annual	***	***				
Rain – Summer	**	***	***	***		
Rain – July	***	***				
Rain – August	NS	***				
Rain – Annual	***	***	***	***	***	***
Temperature – Summer	*	***	**	***		
Temperature – July	NS	NS				
Temperature – August	***	NS				
Temperature – Annual	***	NS			***	
Maximum Temperature – Summer	*	***	**	***		
Maximum Temperature – July	***	NS				
Maximum Temperature – August	NS	***				
Maximum Temperature – Annual	NS	***				
Minimum Temperature – Annual	***	NS			***	
Land Cover	***	***	***	***	***	***
% CORRECT CLASSIFICATION	**72.7**	**75.9**	**69.8**	**74.6**	**72.0** (Step 7)	**76.0** (Step 3)

Model 5 in Table 6, with all variables included, depicts a complete picture of the physical and human impacts on the wildfire patterns of the 2 Chalkidiki peninsulas. According to Model 5, human presence and activities are statistically correlated to wildfire occurrence only in Athos peninsula. Geomorphology is significant for both study areas while there are some differences in meteorological variables. The summer humidity does not influence wildfires in both areas. Rain is significant in Athos, while the summer and the August rain is less- and non-significant, respectively in Sithonia peninsula. Variations in temperature influence are distinguished between the two peninsulas. It is worth noticing that both peninsulas are influenced by different temperature variables. Conclusively, wildfire occurrence in Sithonia is more dependent on temperature than Athos. Finally, land cover is significant for both study areas in conjunction with human impact, geomorphology and climate parameters.

Model 5 for both areas showed the highest correct classification percentages (i.e., 72.7 and 75.9, respectively) and it was selected to map fire occurrence probabilities ranging from 0 to 100 % (Fig.

3). Figure 3 portrays a density function of fire occurrence likelihoods that can be utilized to rate fire danger in the study area, based on environmental hazards and anthropogenic risk criteria.

Table 6 presents two other models that were selected based on human intuition (Model 6) and computer statistical inference (Model 7); they both performed fairly well, the latter having the highest percentage correct classifications with the least number of variables (7 variables for Sithonia and only 3 variables for Athos). In Sithonia, fire has proved once again to be influenced by terrain, weather and vegetation (Model 7); whereas in Mt. Athos, moisture appears to be the most influential factor for explaining vegetation and fire dynamics along the peninsula.

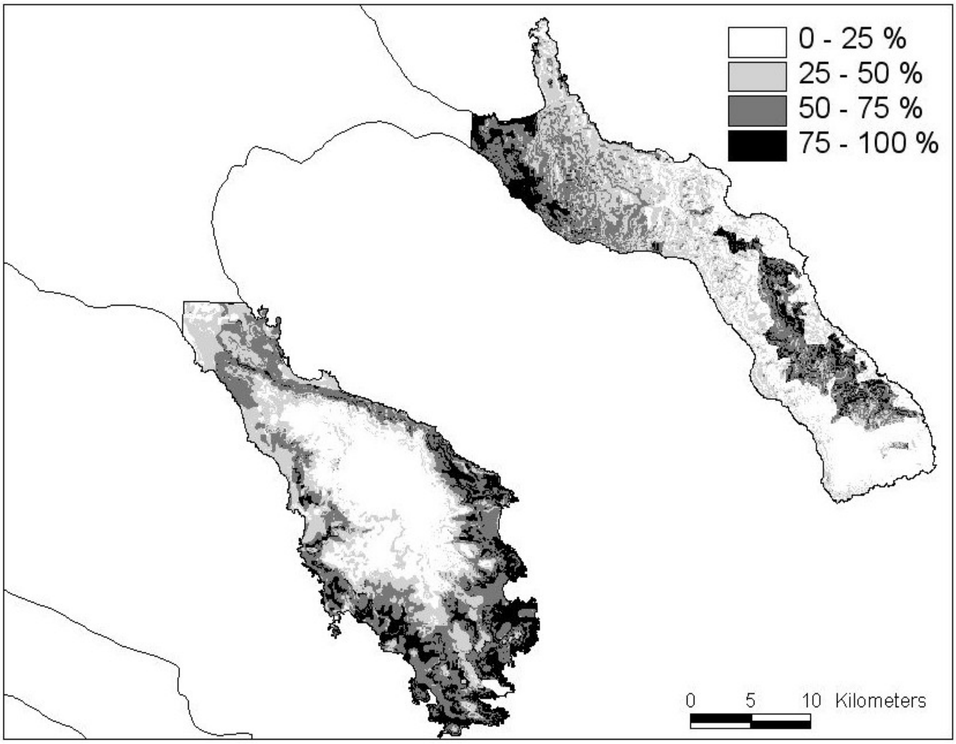

Figure 3. Map of wildfire occurrence probability according to Model 5 (all variables included)

5 CONCLUSIONS

5.1 *Human activities (road network – urban areas – livestock stables)*

Road networks, urban areas and livestock stables constitute the main expression of human activities in the study area. Human impact is significant for evergreen shrub and agriculture lands on both study peninsulas, while chestnut tree forests are also influenced in Mt. Athos. Evergreen shrubs obviously appear, as a result of pine forest degradation, where socio-economical activities are intensified. The relationship among agricultural farms within road, urban and grazing proximity is also justifiable.

Chestnut tree forests and human presence do also show a correlation since these trees are essentially cultivated in Mt. Athos for almost 1000 years; on the contrary, true fir forest are confronted as "pests" and thus grow mainly outside the "urbanized" zones. In relation to the pine forests, they grow in significance with anthropogenic impacts limited only in the northern side of Athos peninsula, away from the monasteries.

5.2 *Geomorphology (elevation – slope – aspect – stream network)*

Geomorphology has a very strong influence on the succession of vegetation. Oak and pine forests along with shrublands are more influenced by the elevation, following the spatial distribution of vegetation zones encountered in the mountains of continental Greece. On the contrary, true fir and chestnut tree forests show a weaker relationship with elevation in Mt. Athos; chestnut trees occur in the eastern part of the peninsula at sea level, thriving on the human intervention and better soil conditions due to mild slopes. True fir also grows in lower elevation westward, compared to its natural occurrence because of the cold air up-wave from the Gulf of Agio Oros (the seawater body in-between the two peninsulas). True firs appear not to be affected by the aspect and stream network, whereas this also the case for the grasslands in Sithonia.

5.3 *Climate (air temperature – relative humidity – precipitation)*

True fir shows small relation with climatic factors, but the annual precipitation. Oak and chestnut tree forests rely more on annual precipitation but also critical summer season humidity than the annual one. Evergreen shrubs do rely on all climatic factors, except for the summer temperatures, in both peninsulas. Agricultural lands and barren soils show less influence on climatic conditions all year long, especially the former ones being under various management regimes.

5.4 *Geology*

All ecosystems of the study areas have a very strong influence by the geological underground, except of the grasslands. In the acidic granites, aleppo and black pine forests along with evergreen shrubs occur extensively, while fir forests grow in calcareous soils where the development of chestnut trees is impossible. In the rest of the soils, oak forests appear either in pure stands or mixed with black pine or other deciduous broadleaved species.

5.5 *Fire*

Fire effect had statistically significant differences between the two peninsulas. In Sithonia, the Mediterranean-type vegetation occurs absolutely independent of the wildfire frequency and extent implying that these plants are very well adjusted to local fire regimes. On the contrary, the non-fire adjusted plants of Athos statistically show critical levels of fire susceptibility, in an area where wildfires are infrequent visitors.

Wildfire behavior and ecology has statistically proved to be influenced by topography, weather and vegetative fuel at the landscape level. The climatic regime (e.g., temperature and moisture) appears to be the most influential factor for explaining vegetation and fire dynamics along the Mt. Athos peninsula, this invaluable world treasure and spiritual preserve of religion, history, culture and Nature.

5.6 *Geo-informatics*

Among the main conclusions of this research was the demonstration of the Geographic Information Systems technology as a powerful tool to statistically analyze complex and multi-facet physical phenomena and mechanisms (sometimes very much chaotic in behavior), including anthropogenic parameters. The use of modern geo-informatics procedures and multivariate analytical processes contributed to better understanding and explanation of landscape wildfire and vegetation dynamics. The study also showed the worth of logistic regression in environmental modeling of natural events that can be expressed in a binary mode, i.e., presence vs. absence.

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